OIL SHALE OCCURRENCES IN
UPPER ASSAM BASIN, INDIA :
AN OVERVIEW

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SEDIMENTARY BASIN MAP OF INDIA
HYDROCARBON RESOURCE BASE

- **Sedimentary Area**: 3.14 Million Sq. Km.  
  (>4% of the world’s sedimentary area)

- **Sedimentary Basins**: 26 (Exploration initiated in 15)

- **Prognosticated Resources**: 205 Billion Barrels  
  (For 15 Sedimentary Basins only; needs up-gradation)

- **Established reserves**: 60 Billion Barrels  
  (As on 01.04.2005)
Only 19% of the total 3.14 million sq. km. has been extensively explored.

< 30% of total prognosticated resources established.

Reserves estimated in only 15 out of 26 basins.

Very low drilling density.
CONTINUOUS EXPANDING ENERGY MARKET

CRUDE OIL (MMT)

<table>
<thead>
<tr>
<th>Year</th>
<th>Demand</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-02</td>
<td>32.03</td>
<td>32.03</td>
</tr>
<tr>
<td>2002-03</td>
<td>33.05</td>
<td>33.05</td>
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<tr>
<td>2005-06</td>
<td>33.98</td>
<td>33.98</td>
</tr>
<tr>
<td>2011-12</td>
<td>33.47</td>
<td>33.47</td>
</tr>
<tr>
<td>2024-25</td>
<td>61.4</td>
<td>61.4</td>
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</tbody>
</table>

NATURAL GAS (MMSCMD)

<table>
<thead>
<tr>
<th>Year</th>
<th>Demand</th>
<th>Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-02</td>
<td>81.4</td>
<td>81.4</td>
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<tr>
<td>2006-07</td>
<td>94.84</td>
<td>94.84</td>
</tr>
<tr>
<td>2011-12</td>
<td>158.05</td>
<td>158.05</td>
</tr>
<tr>
<td>2024-25</td>
<td>391</td>
<td>391</td>
</tr>
</tbody>
</table>
EXPLORATION FOR NON-CONVENTIONAL FOSSIL FUEL RESOURCES IN INDIA
GAS HYDRATES

- The Gas Hydrate exploration and development in India is governed by the National Gas Hydrate Program (NGHP)
- DGH is the technical coordinator for the program
- Investigations for gas hydrates commenced in 1985
- BSR and other indicators found in four offshore basins
- Drilling and coring of sea-bed sediments carried out by R&D vessel JOIDES Resolution at 10 sites in April / May 2006
- High quality gas hydrate samples were recovered at several sites
- Further studies are in progress
COAL BED METHANE

- India has the 4th largest proven coal resources in the world
- India is the 3rd largest producer of coal in the world
- A policy on the development of CBM resources was formulated in 1997 by the Government of India
  - Area opened up for CBM exploration: 13600 sq.km
  - Number of CBM blocks awarded: 26
  - CBM resources in awarded blocks: 48 TCF
  - Production potential in awarded blocks: 1.34 BCFD
  - In CBM-III round, there were 54 bids for 10 blocks
  - Commercial CBM production expected from 2007
OIL SHALE:
THE INDIAN SCENARIO
MAJOR STRUCTURAL ELEMENTS, ASSAM-ARAKAN BASIN
OIL SHALE OCCURRENCE

- Carbonaceous shale of Oligocene age occurs in association with Tertiary Coal in Assam and neighboring areas of Arunachal Pradesh.

- The coal-shale unit occurs as outcrops towards south of the oilfields in a region called the Belt of Schuppen.

- The presence of coal and organic rich shale has been recorded in the subsurface from wells drilled for oil.

- The coal-shale unit was probably deposited in a regressive phase in backwater lagoons or brackish water swamps on a prograding delta complex.
ABOUT THE AREA

- THE AREA IS THICKLY FORESTED AND LOGISTICALLY DIFFICULT

- THE WELL KNOWN DIGBOI OIL FIELD IS LOCATED IN THE VICINITY

- MORE THAN A CENTURY OF OIL PRODUCTION FROM THE DIGBOI FIELD (SINCE 1889)
SCHEMATIC GEOLOGICAL SECTION ACROSS BRAHMAPUTRA VALLEY
SCHEMATIC GEOLOGICAL SECTION ACROSS THE NAGA SCHUPPEN ZONE (NSZ) AND THE ASSAM – ARAKAN FOLD BELT (AAFB)
Currently, coal mining is actively pursued in this area.

The associated organic rich shale is dumped as waste material.

Oil India Limited, a public sector undertaking has set up a pilot plant for production of syncrude from coal.
CURRENT UNDERSTANDING

• Although presence of oil shale is known, exact stratigraphic position, thickness and extent of the horizons are not known.

• Systematic exploration, sampling and analysis in potential areas is required.

• The potential areas are located in the northern part of the Belt of Schuppen.
CURRENT UNDERSTANDING

• The favorable characteristics of Tertiary coal in north eastern part of India has been known for a long time

• In the late 80’s the coal and associated shale were re-examined for their potential as oil shale

• Rock-Eval yields proved to be quite encouraging
CHARACTERISTICS OF OLIGOCENE COAL

- The Oligocene coal are soft and friable in nature

- **Moisture content**: 1-3%

- **Low ash content**: 2-10%

- **High volatile content**: 40-48%

- **High Sulfur content**: 1.5 to 5%

- **Carbon content**: 78 to 82%

- **Nitrogen content**: 1.2 to 1.6%

- **Oxygen content**: 7.6 to 11%

- **High vitrinite content**: 80 to 90%

- **Low exinite content**: 5 to 10%

- **Inertinite content**: 5 to 10%
CHARACTERISTICS OF BARAIL

- AVERAGE VITRINITE REFLECTANCE IN OIL RANGES FROM 0.5 TO 0.7%.

- ROCK-EVAL Tmax VALUES ARE LESS THAN 435°C INDICATING LOW THERMAL MATURITY

- THE ORGANIC MATTER IS PREDOMINANTLY TYPE-II + TYPE-III

- BIOMARKER RATIOS INDICATE A DOMINANCE OF LAND PLANT DERIVED KEROGEN: preponderance of C_{29} \alphaR steranes and high hopane/sterane ratio

- SULFUR CONTENT IS HIGH: 1.5 to 5%
## Rock-Eval Results for Barail
*(Surface / near-surface samples)*

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>TOC (%)</th>
<th>S1 (mg/g)</th>
<th>S2 (mg/g)</th>
<th>Tmax (°C)</th>
<th>HI</th>
<th>OI</th>
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</thead>
<tbody>
<tr>
<td>Mta-1</td>
<td>77.02</td>
<td>8.76</td>
<td>288.38</td>
<td>435</td>
<td>374</td>
<td>5</td>
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<tr>
<td>Mta-2</td>
<td>64.74</td>
<td>8.15</td>
<td>255.24</td>
<td>431</td>
<td>394</td>
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<td>Mta-3</td>
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<td>7.91</td>
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<td>Mak-1</td>
<td>15.99</td>
<td>1.19</td>
<td>34.37</td>
<td>436</td>
<td>214</td>
<td>59</td>
</tr>
<tr>
<td>Dli-1</td>
<td>38.96</td>
<td>6.89</td>
<td>222.43</td>
<td>425</td>
<td>570</td>
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<tr>
<td>Trp-1</td>
<td>12.75</td>
<td>2.62</td>
<td>44.73</td>
<td>436</td>
<td>350</td>
<td>43</td>
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<tr>
<td>Trp-2</td>
<td>14.89</td>
<td>2.54</td>
<td>53.75</td>
<td>432</td>
<td>360</td>
<td>-</td>
</tr>
</tbody>
</table>
ROCK-EVAL HI vs OI PLOT SHOWING KEROGEN TYPES

- TYPE - I
- TYPE - II
- TYPE - III

Barail (Oligocene)
Eocene
ROCK-EVAL HI vs $T_{\text{MAX}}$ PLOT

HYDROGEN INDEX (mg HC/g TOC)

TYPE - III

Barail (Oligocene)

Eocene

Immature Oil zone Gas zone

$T_{\text{max}}$ (°C)
STERANE TERNARY PLOT FOR CRUDE OILS
## NORTH EAST COAL / OIL SHALE RESERVES AND SYNCRUDE POTENTIAL

<table>
<thead>
<tr>
<th></th>
<th>RESERVES</th>
<th>SYNCRUDE POTENTIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PROVED + INDICATED (MMT)</td>
<td>PROVED + INDICATED MMT (Billion BBls)</td>
</tr>
<tr>
<td>BARAIL SERIES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COAL</td>
<td>2250</td>
<td>405 (2.997)</td>
</tr>
<tr>
<td>BARAIL SERIES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OIL SHALE (Uncertain)</td>
<td>27000</td>
<td>2700 (19.98)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>29250</td>
<td>3105 (22.977)</td>
</tr>
</tbody>
</table>

Source: ‘Urja’
CONCLUSIONS

- Although presence of rocks with favorable characteristics of oil shale are known, the reserves are not known at present.
- More field and laboratory studies are required for a realistic assessment of the oil shale resources.
- Appropriate technology for exploitation of the coal and oil shale needs to be looked into.
CONCLUSIONS

- DGH has initiated a project for the assessment of the oil shale resources of Assam and neighboring area.

- For oil shale development in India, interaction with agencies actively engaged in oil shale is required.

- Since the area is forested and part of a fragile ecosystem, the exploitation of oil shale entails environmental concerns which needs to be addressed.
THANK YOU